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A Review on Understanding the Progression of Trachoma and Its Preventive Measures in the Community

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ABSTRACT
Trachoma is the leading infectious cause of blindness worldwide, resulting from recurrent infection with ocular strains of chlamydia trachomatis. While once widespread in Europe and the Americas, its significant decline by the end of the 20th century was attributed to improved socioeconomic conditions and hygiene. Women and girls are particularly vulnerable to infection, as they are often the primary caregivers of children, and children are the greatest source of infection with Trachoma. As prevention option to Trachoma, World Health Organization recommends Facial cleanliness (F), Environmental Improvement (E), Antibiotics (A) and Surgery (S), which abbreviated as "SAFE". The disease causes inflammation and scarring on the surface of the eye resulting in the margin of the eyelid turning inwards. Consequently, the eyelashes become inverted and scratch the cornea. This abrasive action of the lashes damages the cornea and is termed trachomatous trichiasis, the complex stage of the disease. Novel diagnostic tests such as confocal microscopy are supplementing current diagnostic criteria; mass treatment strategies are proposing effective methods for antibiotic distribution, and studies exploring the external benefits of trachoma control programs show promising effects on lowering trachoma cases in the community. Surgery is recommended for patients with trachoma to prevent the eyelashes from rubbing against the eyeball and causing corneal damage. Understanding nature of infection and preventive measures can assist to promote safe preventive strategies in the community.

Keywords
Trachoma, Infection
Diagnostic test
Inflammation
Antibiotic
Preventive measures

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Introduction

Trachoma is a debilitating eye disease caused by the Chlamydia trachomatis bacterium and is one of the leading causes of blindness worldwide. If left untreated, this bacterial illness primarily affects the conjunctiva, leading to recurrent cycles of inflammation, roughening, and scarring of the inner surface of the eyelids, as well as erosion of the corneal surface. These ocular complications often result in permanent blindness. The World Health Organization has classified 20 illnesses and disease groupings as neglected tropical diseases, including trachoma, which is considered the most frequent infection that causes visual impairment in underprivileged countries. As living standards have improved, trachoma has declined significantly in most North American and European countries[1-3]. Sharp reductions in the worldwide burden of the disease have been attributed to intentional management measures implemented over the past few decades. However, despite prolonged and intensive interventions, the prevalence of trachoma persists in certain cultures.

Stages of Trachoma

Trachoma manifests in 2 distinct stages, each presenting unique symptoms and complications.

First-phase symptoms: These symptoms include persistent keratoconjunctivitis characterized by inflammation of the conjunctiva, known as active trachoma. This inflammation results from recurrent infections with conjunctival strains of the bacterium C trachomatis.

Second-phase symptoms:

The progression to the second stage of the illness is marked by periods of intense conjunctival inflammation, leading to eyelid scarring. Trichiasis is a disorder in which the eyelashes rotate inward and come in touch with the eyeball due to scarring. In addition, a condition called entropion can occur concurrently with trichiasis, where a portion or all of the eyelid edge curls inward. Inverted eyelashes that scratch the cornea increase the risk of corneal opacity and visual problems, leading to blindness in severe chronic conditions.

In addition, it is essential to understand how trachoma is transmitted to implement preventative measures. Trachoma mainly spreads through direct and indirect contact with secretions from the noses and eyes of infected individuals. Additionally, transmission can occur through direct contact, hand-eye contact, contact with contaminated objects (fomites),

and eye-seeking flies. Several factors contribute to the spread of trachoma, including crowded living conditions, poor hygiene practices, and limited access to medical care. Additionally, socioeconomic status, climate, and cultural customs play significant roles in the transmission of the disease[4-6].

These factors, often referred to as the "3 F's" in studies, contribute to its dissemination among populations:

- Face-to-face contact: Close contact facilitates the rapid transmission of the highly infectious trachoma disease. This often happens through actions such as kissing, embracing, or sharing intimate objects such as towels and washcloths with an affected individual. During such interactions, the exchange of infected nasal and ocular secretions between individuals can easily spread the bacteria from one person to another.
- **Flies:** Flies, particularly species such as Musca sorbens, have a significant role in the transmission of trachoma. These flies are attracted to the secretions from people's noses and eyes and act as mechanical vectors by carrying the bacteria on their bodies. Subsequently, they transfer the infection from one person to another. This mode of transmission is especially common in unsanitary environments where flies are plentiful.
- **Fomites:** Fomites, such as contaminated inanimate objects or surfaces, also contribute to the spread of the bacteria. Infected individuals can transfer the bacterium to items such as linens, towels, or everyday utensils. Those who subsequently come into contact with these contaminated fomites and then touch their face or eyes are at risk of contracting the bacteria.

History

The disease is one of the earliest known eye afflictions, having been identified in Egypt as early as 15 BCE. It became a particular problem in Europe in the 19th century. After the Egyptian Campaign (1798–1802) and the Napoleonic Wars (1798–1815), trachoma was rampant in the army barracks of Europe and spread to those living in towns as troops returned home. Stringent control measures were introduced, and by the early 20th century, trachoma was essentially controlled in Europe, although cases were reported until the 1950s. Today, most victims of trachoma live in underdeveloped and poverty-stricken countries in Africa, the Middle East, and Asia.

Etiology

The causative agent of trachoma, the C trachomatis bacterium, is transmitted from infected to uninfected individuals through various means, including direct eye-to-eye spread during close contact, hand-eye contact, indirect transmission via contaminated objects (fomites), and transmission facilitated by eye-seeking flies. Several factors, including crowded living arrangements, poor hygiene habits, and restricted access to sanitary facilities and clean water, contribute to the spread of trachoma. These conditions create an environment conducive to the growth and persistence of C trachomatis bacteria within communities, continuing the infection cycle. Understanding the root causes of trachoma is crucial for developing targeted measures to stop the disease's spread, address ongoing infections, and mitigate its long-term impact. C trachomatis can cause ocular infections such as trachoma, infections transmitted through sexual activity in humans. Trachoma primarily affects the conjunctiva. The interaction between the life cycle of bacteria and the host's immune system plays a crucial role in the development of trachoma. Upon entering the eye, C trachomatis initiates the infection by entering the epithelial cells of the conjunctiva and undergoes a biphasic developmental cycle. The infectious form of the bacteria, known as the elementary bodies, initially binds to and penetrates the host cells.

Pathophysiology

The pathophysiology of trachoma is characterized by the development of conjunctival scarring, which results from recurrent cycles of tissue repair and inflammation. Extracellular matrix proteins such as collagen and fibronectin are deposited throughout the scarring process, leading to fibrosis and contraction of the conjunctival tissue. Without treatment for this fibrotic scarring, complications such as eyelid entropion (inward turning of the eyelid) and trichiasis (misalignment of the lashes) may occur, potentially resulting in corneal abrasions, ulcerations, and eventual blindness. Bacterial infection, inflammatory reactions, tissue remodeling, and host factors intricately interact in the pathophysiology of trachoma[7-8].

Trachoma is primarily associated with infections by serovars A, B, Ba, and C of the C trachomatis bacterium, while serovars D to K are typically linked to adult inclusion conjunctivitis. Other species within the Chlamydiaceae family, such as Chlamydophila psittaci and C pneumoniae, have also been implicated. Trachoma infection progresses through an initial 'active' inflammatory stage, which is more prevalent in preschool children. This stage may be mild and only result in trachomatous conjunctivitis (follicular or papillary), with the presence of papillary hypertrophy characterizing more severe cases. Recurrent infection triggers a chronic immune response provoked by intermittent chlamydial antigens. This response manifests as a cell-mediated delayed hypersensitivity (type 4) response. The repeated insult from these antigens leads to scarring and other forms of permanent damage. This chronic "cicatricial" stage typically occurs in middle age, with most scarring concentrated on the upper tarsal plate. As this scar tissue contracts, it causes the in-turning of the lid, resulting in entropion, which eventually leads to trichiasis. Entropion is the most common cause of trichiasis in trachoma patients. However, in rare cases, trichiasis may also occur due to aberrant lashes or metaplastic lashes. Ultimately, blinding corneal opacification can develop as a result of these complications[9].

Clinical symptoms includes:

- Eye discharge
- Swollen eyelids
- Trichiasis (misaligned eyelashes)
- Swelling of lymph nodes in front of the ears
- Sensitivity to bright lights
- Increased heart rate
- Further ear, nose, and throat complications.

Causes

Trachoma is caused by Chlamydia trachomatis, serotypes (serovars) A, B, and C. It is spread by direct contact with eye, nose, and throat secretions from affected individuals, or contact with fomites (inanimate objects that carry infectious agents), such as towels and/or washcloths, that have had similar contact

with these secretions. Flies can also be a route of mechanical transmission. Untreated, repeated trachoma infections result in entropion (the inward turning of the eyelids), which may result in blindness due to damage to the cornea. Children are the most susceptible to infection due to their tendency to get dirty easily, but the blinding effects or more severe symptoms are often not felt until adulthood. Blinding endemic trachoma occurs in areas with poor personal and family hygiene. Many factors are indirectly linked to the presence of trachoma including lack of water, absence of latrines or toilets, poverty in general, flies, close proximity to cattle, and crowding. The final common pathway, though, seems to be the presence of dirty faces in children, facilitating the frequent exchange of infected ocular discharge from one child's face to another. Most transmission of trachoma occurs within the family[10].

Risk factors

- Crowded living conditions. People living in close contact are at greater risk of spreading infection.
- Poor sanitation. Poor sanitary conditions, inadequate access to water, and lack of hygiene, such as unclean faces or hands, help spread the disease.
- Age. In areas where the disease is active, it's most common in children ages 4 to 6.
- Sex. In some areas, women's rate of contracting the disease is two to six times higher than that of men. This may be attributed to the fact that women have more contact with children, who are the primary reservoir of infection.
- Flies. People living in areas with problems controlling the fly population may be more susceptible to infection.

Diagnosis of Trachoma

Accurate trachoma diagnosis helps distinguish it from other forms of conjunctivitis or eye allergies. Doctors rely on both clinical signs and laboratory tests to confirm the infection:

Clinical examination: The doctor examines the eyelids and conjunctiva for follicles, scarring, or inward-turning lashes.

Conjunctival swab tests:

Samples from the inner eyelid are Analysed for Chlamydia trachomatis using nucleic acid amplification tests (NAATs).

Microscopic analysis: Identifies bacterial inclusions within conjunctival cells.

Vision assessment: To determine corneal damage or blindness.

Treatment Options

Trachoma treatment focuses on eliminating the infection, managing inflammation, and preventing blindness. Depending on disease severity, treatment includes:

Antibiotic therapy: A single oral dose of azithromycin (as recommended by WHO for community use) effectively clears the infection[11-12]. Alternatively, topical tetracycline eye ointment may be used twice daily for six weeks.

Surgical correction: In advanced cases (trichiasis), surgery is required to reposition the eyelid and prevent lashes from scraping the cornea.

Facial hygiene: Regular cleaning of the face and eyes helps prevent reinfection.

Community treatment programmes:

Mass drug administration in endemic regions treats entire communities simultaneously[13-14].

Prevention strategies

Surgery: Corrects trichiasis (in-turned eyelashes) to prevent permanent corneal damage.

Antibiotics: Mass Drug Administration (MDA) with antibiotics, commonly azithromycin, is used in communities with high prevalence to reduce the infection reservoir.

Facial Cleanliness: Educating communities to wash faces and hands regularly, especially for children, to remove eye and nose discharge that attracts flies.

Environmental Improvement: Increasing access to water and soap for hygiene, improving waste management, and reducing fly populations15-16.

Avoid Sharing Items: Do not share towels, washcloths, or bedding.

Personal Hygiene: Consistently wash faces and hands with water and soap to prevent the transmission of Chlamydia trachomatis.

Environmental Sanitation:

Proper disposal of waste and, if possible, reducing overcrowding in homes to minimize the spread of the bacteria[17].

Control Flies: Eliminate or manage breeding sites to prevent the spread of the infection from person to person.

Conclusion

Trachoma is a preventable cause of blindness, and its elimination is within reach through early testing, timely treatment, improved sanitation, and community awareness. Together, with timely care and hygiene, we can create trachoma-free world. Trachoma prevention, primarily driven by the WHO-endorsed SAFE strategy (Surgery, Antibiotics, Facial cleanliness, Environmental improvement), is effective at reducing disease prevalence, though long-term success relies heavily on sustained hygiene behavior and sanitation improvements. While antibiotics (azithromycin) are effective for short-term reduction, environmental changes (latrines, water access) are essential for sustainable elimination. Recent research studies suggest that ancillary benefits from mass antibiotic distributions, including possible reductions in infectious diseases and even childhood mortality. Integrating trachoma prevention programs can lower the health care cost.

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Conflict of Interests

The authors declare no conflict of interest

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AI Tool Declaration

The authors declare that no AI and related tools are used to write the scientific content of this manuscript.

Data Availability

Data will be available on request

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